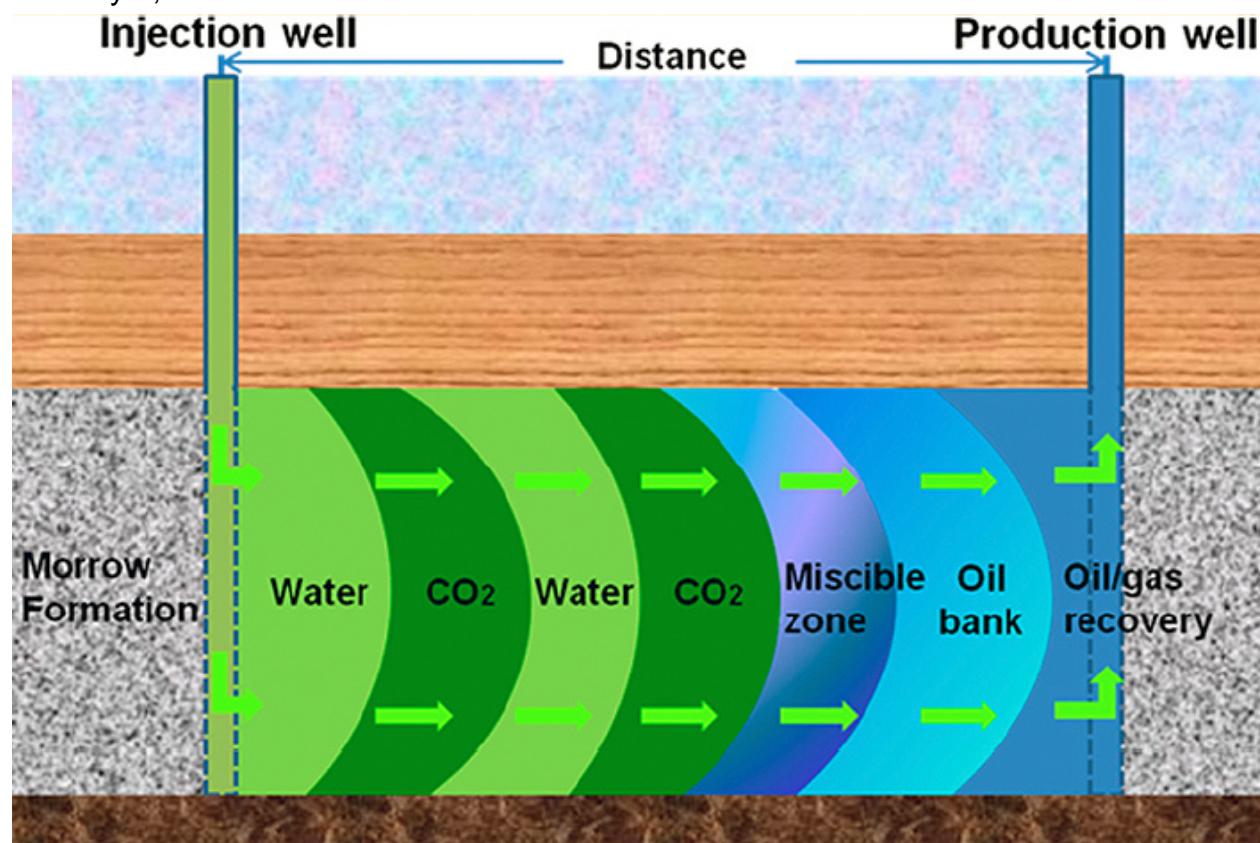


Optimize carbon dioxide sequestration, enhance oil recovery

January 8, 2014



Los Alamos researchers and collaborators from the University of Utah have created a generic integrated framework simulation to optimize carbon dioxide (CO₂) sequestration and enhance oil recovery (CO₂-EOR) based on known parameter distributions for a depleted oil reservoir in Texas. CO₂-EOR is a technique in use for over 40 years to produce oil from depleted reservoirs by injecting CO₂ along with water. Because a large portion of the injected CO₂ remains in place, CO₂-EOR is an option for permanently sequestering CO₂. The simulation provides an important approach to estimate the potential of storing CO₂ in depleted oil fields while simultaneously maximizing oil production. The journal [*Environmental Science & Technology Letters*](#) published the research.

Significance of the research

CO₂-EOR provides about 5 percent of the total U.S. current crude oil production. Due to carbon capture and storage technology advances, prolonged high oil prices and the potential availability of large anthropogenic CO₂ sources, CO₂-EOR could expand in the next few decades. The technology uses water-alternating-with-gas cycles to control CO₂ mobility and CO₂ flood conformance and to tackle the clogging and scale issues in the depleted reservoir.

However, there are a few operational and technical issues to be resolved for CO₂-EOR expansion to commercial scales: 1) uncertainty in characterizing CO₂-water-oil systems in depleted reservoirs, 2) lack of robust guidelines for determining injection and production well distances, 3) difficulty in determining the time ratio for water alternating CO₂ gas injection, and 4) difficulty in controlling the CO₂ flood conformance and monitoring the flood performance. If the first three issues can be quantitatively evaluated and solved, the results will indirectly help solve the fourth issue of CO₂ flood conformance and performance evaluation.

The LANL and University of Utah researchers developed a generic integrated framework simulation to optimize CO₂ sequestration and enhance oil recovery based on known parameter distributions for a depleted oil reservoir. The framework consists of a multi-phase reservoir simulator coupled with geologic and statistical models. The results from this study provide insights to understand the potential and uncertainty of commercial-scale CO₂-EOR.

Research achievements

The team conducted an integrated simulation of CO₂-water-oil flow and reactive transport, followed by a global sensitivity and response surface analysis. The source of CO₂ used by the test came from a fertilizer plant in Borger, TX, and an ethanol plant in Liberal, KS. The results optimized the CO₂-EOR process. The scientists found that the reservoir permeability, porosity, thickness, and depth are the major reservoir parameters that control net CO₂ injection/storage and oil/gas recovery rates. The distance between injection and production wells and the sequence of alternating CO₂ and water injection are the significant operational parameters to design a five-spot CO₂-EOR pattern that efficiently produces oil while storing CO₂.

The research team

LANL researchers include Zhenxue Dai, Richard Middleton, Hari Viswanathan, Jacob Bauman, and Rajesh Pawar of the Computational Earth Science group; Julianna Fessenden-Rahn of the Defense Systems and Analysis group; and Si-Yong Lee and Brian McPherson of the University of Utah. This work is Phase III of the Southwest Partnership CO₂-Enhanced Oil Recovery/Storage Project that DOE sponsors and the National Energy Technology Laboratory manages. The research supports LANL's Energy Security mission area and the Information, Science, and Technology science pillar.

Caption for image below: Schematic of a five-spot CO₂-EOR pattern and model permeability distributions.